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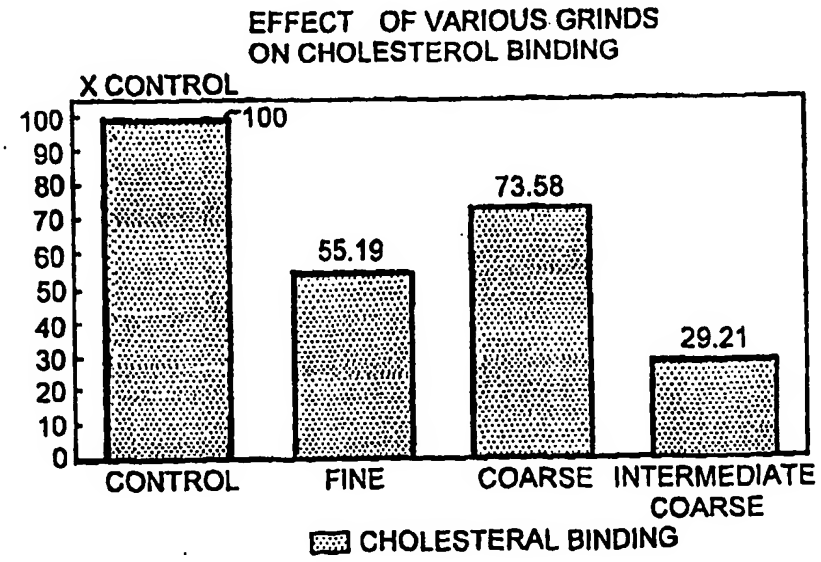

(57) Abstract

A fenugreek seed material having reduced odor and taste is provided. Products derived from the fenugreek seed material are also provided. The fenugreek seed material of the invention has reduced odor and taste compared to native fenugreek but maintains all of the biological activity of native fenugreek. Methods for reducing the intestinal absorption of a caloric and/or cholesterol compound from a caloric and/or cholesterol containing comestible in a human and for removing cholesterol from a cholesterol containing comestible are also provided.

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FENUGREEK COMPOSITIONS HAVING REDUCED TASTE AND ODOR AND METHODS OF USE

Background of the Invention

Fenugreek, (trigonella foenum-graecum), an aromatic plant from the family of leguminosae found predominantly in Mediterranean countries and in Asia, has been important for many centuries as a food, as spice for flavoring of food products, and in traditional herbal medicines.

The seeds of the fenugreek plant, which have a very strong odor and taste, have been used as a flavoring agent in a variety of food products. For instance, ground fenugreek seeds are commonly found in Indian curry spices. In various other cultures ground fenugreek seeds have been used to make tea or mixed with water and other substances to form a thick dip called hilba. More recently, various extracts of fenugreek seeds have been used as seasonings in coffee, vanilla extracts, chutney, tobacco flavorings, and artificial maple syrup.

For centuries, extracts of fenugreek seeds also have been used in herbal medicines for the treatment of a variety of disorders. For example, it is believed that fenugreek seeds are useful for treating the symptoms of menopause and as a gelatinous soother for irritated tissues to help relieve sore throat pain, cough, and minor indigestion. *(The Complete Book of Natural and Medicinal Cures*, Prevention Magazine, p. 325-327.) More recently, studies aimed at identifying the medicinal properties of fenugreek seeds have revealed that fenugreek seeds are useful for regulating glucose levels in diabetics and for reducing cholesterol levels in patients with high cholesterol.

Diabetes mellitus, which encompasses both Type I (i.e., Insulin Dependent Diabetes Mellitus (IDDM)) and Type II (i.e., Non-Insulin Dependent Diabetes Mellitus (NIDDM)), is known to affect more than one hundred million individuals worldwide. Although the exact cause of diabetes is unclear it is believed that diabetes may arise from any of a variety of physiological conditions such as genetic syndromes, viral infections, age related deterioration of structures responsible for maintaining the glycemic response, pancreatic disease, hormonal abnormalities, certain drugs or chemicals, insulin receptor abnormalities, etc.

Approximately five percent of the United States population is believed to be inflicted with diabetes. One fourth of these diabetics have insulin dependent disease, while three fourths have non-insulin dependent disease. The symptoms associated with IDDM result from the destruction of beta cells in the pancreas, generally by an autoimmune reaction. Patients with

Type II non-insulin dependent diabetes exhibit abnormal insulin secretion and resistance to insulin action in target tissues.

Although the underlying mechanisms associated with IDDM and NIDDM are different, both diseases result in the same diabetic complications. Complications associated with diabetes include circulatory abnormalities including coronary artery disease and stroke, retinopathy, nephropathy, neuropathy, foot ulcer, blindness, amputations, and kidney failure.

In order to prevent the complications associated with diabetes, the levels of glucose and insulin in diabetics must be carefully monitored and regulated. Diabetics may be prescribed a restricted diet by a physician. Generally carbohydrates are recommended as forty to sixty percent of the total energy intake. Consumption of sucrose is usually forbidden. In addition to diet restrictions, dietary fiber has been demonstrated to slow the absorption of sugar from the intestine, preventing the rise in blood glucose that ordinary follows the ingestion of carbohydrates.

Additionally, oral pharmaceutical agents are used to control glucose levels in patients with type II diabetes. Such agents include sulfonylureas, which stimulate the pancreas to secrete more insulin, metformin, which enhances the action of insulin on the liver and muscles, and acarbose, which interferes with the intestinal digestion of carbohydrates.

Some NIDDM diabetics may be treated to maintain glucose levels through regulation of diet without the administration of insulin. Diabetics with more severe cases of NIDDM and those unable to follow a strict diet may be administered insulin in combination with a regulated diet. If the diet of these patients is carefully regulated, insulin administration may be reduced but not eliminated.

All patients with IDDM must be administered insulin daily, either by oral agents, periodic injections or infusion pumps. In conventional insulin therapy, one or two doses of modified insulin, sometimes containing small amounts of regular insulin, are injected. Multiple subcutaneous insulin injection involves the administration of a long acting insulin as a single dose in the evening with the administration of regular insulin prior to each meal. Continuous subcutaneous insulin infusion involves the delivery of insulin subcutaneously into the abdominal wall by a battery driven pump.

In normal nondiabetic subjects, the plasma glucose concentration is maintained within a normal range despite large variations in food intake. This is the result of a rapid release of insulin after a meal which immediately transports the carbohydrate to the liver and other tissues.

Only enough insulin is released to maintain a normal postprandial glucose level. As the level of plasma glucose decreases, the release of insulin is inhibited. When a diabetic subject is administered insulin, the insulin is often not capable of maintaining the plasma glucose concentration within the same narrow range as would be found in a normal subject. If not enough insulin is administered, a hyperglycemic effect is seen. If an appropriate amount of insulin is given to maintain a normal postprandial glucose level, often too much insulin is then present during the post-absorptive phase and hypoglycemia results.

Fenugreek seeds have been found to have a hypoglycemic effect in diabetic subjects. Sharma, R.D., *Nutrition Research*, v. 6, p. 1353-1364 (1986). When ground fenugreek seeds are mixed with food or administered concurrently with food to diabetic animals, postprandial glucose levels are reduced. Madar, *Nutr. Rep. Inter.*, v. 29, p. 1267-1273 (1984); Ribes et al., *Ann. Nutr. Metab.*, v. 28, p. 37-43 (1984). Additional studies have revealed that fenugreek is useful for reducing plasma post-prandial glucose in NIDDM. Arad, Y. et al., *Clinical Nutrition*, 23, p. 121-125). These studies have important implications for the treatment of diabetes because they suggest that fenugreek may allow a diabetic to consume a less restricted diet without increasing the amount of insulin required. Although several research studies have suggested that fenugreek be administered to diabetics because of the hypoglycemic effect of the seeds, fenugreek is not routinely administered.

Fenugreek has also been demonstrated to reduce cholesterol levels in hypercholesteremic patients. High levels of blood cholesterol have been causally linked with atherosclerosis due to an accumulation of cholesterol on blood vessel walls resulting in plaque formation. Several research studies have indicated that in addition to the fiber, the cholesterol lowering effect of fenugreek is due to the saponin fraction of the seed. It has been hypothesized that saponins and cholesterol form insoluble complexes which prevent or reduce cholesterol absorption in the intestine. Alternatively the saponin may increase the conversion of cholesterol to bile acids in the liver, thus reducing the plasma cholesterol level. Sauvaire et al., *Lipids*, v. 26, n. 3, p. 191-197 (1991). Saponins from a variety of plant sources have been demonstrated to be useful for removing cholesterol from food products *in vitro*. *See e.g.*, U.S. Patent No. 5,370,890.

Many researchers have attempted to identify the active components of fenugreek which are responsible for the anti-diabetic and hypocholesteremic effects. The studies have involved the preparation of various types of extracts of fenugreek followed by assays for the biological activity. The studies have produced variable results. Some investigators have attributed the

beneficial biological effects of fenugreek to the galactomannans, whereas, others have attributed these effects to either saponins or the proteins.

Groups such as Ribes et al., Sharma, Sauvaire et al., and Garti et al. produced fenugreek extracts which maintain the anti-diabetic activity of intact fenugreek but with the removal of several other components of fenugreek.

Ribes et al. produced an extract of fenugreek by grinding mature fenugreek seeds into a powder. The powder was then mixed into a solution containing trifluorotrichloroethane and hexane which promotes the separation of the different histological parts of the seed based on density. Two fractions were separated and defatted with hexane using a soxhlet apparatus and their anti-diabetic activity was measured. Ribes et al. concluded that the fraction containing the testa and endosperm of the seeds were responsible for the anti-diabetic action of fenugreek. Ribes et al., *P. Soc. Exper. Biol. Med.*, v. 182, p. 159-166 (1986).

Sharma prepared an extract of fenugreek seeds to determine which components within the seeds were capable of eliciting the hypoglycemic effect. The fenugreek seeds were cleaned and ground in a cyclone mill to produce a 40 mesh powder. The powder was then extracted with ether in a soxhlet extractor for 16 hours, followed by an alcohol extraction for 24 hours. The extracted powder was then air dried on a filter paper for 4-5 days at room temperature. Sharma noted that the defatted extract was not bitter to taste and was free of lipids and saponins. When the hypoglycemic activity of the fenugreek extracts were compared with that of the fenugreek seeds in human subjects, the fenugreek extract exhibited a significant response. Sharma concluded that the lipids and saponins are not critical to the hypoglycemic effect and that the hypoglycemic activity of fenugreek is due to the gum fiber found in the fenugreek extract. Sharma, *Nutrition Research*, v. 6, p. 1353-1364 (1986).

In an attempt to isolate the hypoglycemic activity of fenugreek from fenugreek seeds, Sauvaire et al. prepared ground fenugreek seeds and extracted the lipid with hexane at room temperature to produce a delipidized cake. The delipidized cake was then subjected to a series of successive 70% ethanol extractions at room temperature. The extract was then concentrated and passed over a cation exchange column. The concentrated product was eluted from the column with 2N ammonia and then further concentrated, mixed with ethanol and subject to adsorption chromatography to separate the 4-hydroxyisoleucine. Sauvaire then demonstrated that the 4-hydroxyisoleucine product maintained the anti-diabetic activity of fenugreek. U.S. Patent No. 5,470,879.

Garti, in published PCT patent application WO95/21199 disclosed that the galactomannan component of fenugreek is responsible for the anti-diabetic activity and disclosed several methods for preparing isolated galactomannan from fenugreek seeds. Each extraction procedure produced a product having less than 20% protein, less than 5% saponin, and less than 1% lipid. In preferred embodiments, the extract had less than 15% protein, less than 2% saponin, and less than 0.1% lipid. The first method disclosed involved the grinding of dry fenugreek seeds to a fine powder. Lipid was then extracted from the powder utilizing hexane in a soxhlet apparatus. The remaining solid fraction was then further extracted with methanol, followed by ethanol. The remaining product was vacuum dried and then dissolved in water to form a viscous aqueous solution of crude fenugreek gums. After repeating the extraction procedure several times, the water soluble fractions were combined and the gum was precipitated out using ethanol. The gum was dried and ground into a powder. The gum powder was used in biological activity assays or was optionally percolated through a florusil column to eliminate more protein. A second method for producing the galactomannan gum involved grinding fenugreek seeds to a fine powder, which was then combined with water and heated. A liquid was separated from the solid phase by centrifugation and combined with ethanol to precipitate out galactomannan gum. Again, the gum material was dried and ground to form a powder. In a third method, the fenugreek seeds were crushed and introduced into a solvent having a specific gravity range of between 1.25 and 1.35, and selected from CH_2, Cl_2, $CHCl_3$, and CCl_4. The gummed components of the outer coating of the seeds were allowed to settle to the bottom in the solvent and were isolated. This material was then ground to a fine powder combined with water and heated. A liquid was separated from a solid phase by centrifugation and combined with ethanol to precipitate out the gum.

Several researchers have also attempted to identify the active hypocholesteremic components of fenugreek. Petite et al. identified the steroid saponins as being the active hypocholesteremic component of fenugreek. Petite et al. prepared a purified steroid saponin extract from fenugreek seeds by grinding fenugreek seeds in a mag grinder to produce a powder that could pass through a 0.8 mm mesh sieve. The powder was then extracted with ethanol/water (25:75, v/v) at room temperature for three hours, and then centrifuged to form a pellet. The extraction step was repeated three times on the pellet. Each of the supernatants was combined and concentrated under vacuum at a temperature below 50°C and defatted with hexane. The extract was then dried and solubilized with a mixture of water and ethanol. The material was

precipitated with alcohol to remove the gum component and the hydroalcoholic extract was passed over an ion exchange column to produce a steroid saponin extract having at least 90% purity. Petite et al. demonstrated that the pure steroid saponin extract caused a significant decrease in plasma cholesterol in both normal and diabetic rats. The extract, however, did not modify plasma insulin or blood glucose levels in rats, suggesting that the hypoglycemia or hyperinsulinemia previously observed by fenugreek seed administration was not due to saponin. Petite et al., *Steroids*, v. 60, p. 674-680 (1995).

Procedures for extracting various components of fenugreek seeds have been performed for a variety of other reasons. For example, Raymond et al. disclosed in U.S. Patent No. 5,301,694, a method for preparing plant extracts which have the flavor of tobacco but without the nicotine. A variety of plants may be used in the preparation of such an extract, including fenugreek. The process for preparing plant extracts which are useful as flavoring agents involves a solvent extraction of the plant material in water, ethanol or mixtures thereof at a temperature of between 30°C and 60°C. The solvent is then removed by evaporation and the solid is subjected to a size exclusion process to produce the plant extract flavoring agent.

The volatile constituents of fenugreek seeds were characterized and tested for activity by Girardon et al. Girardon et al., *Planta Medica*, p. 533-534 (1985). Three fenugreek extracts were prepared. The first extract was produced by head space vacuum entrainment of the seed. It was found that several carbonyl compounds of high aroma value were lost during head space vacuum entrainment. Two other extracts were prepared by steam distillation of the seeds at atmospheric pressure. Four monoterpenoids, usually found in essential oils, were detected in one of the steamed distillation extracts. Fifty-one constituents were detected in the three extracts. Although the authors hypothesized that several of these components may contribute to the characteristic odor of fenugreek, the theory was not tested. Furthermore it is unclear from the study whether all of the components contributing to the odor and taste of the fenugreek were removed from the extracts or whether the extracts retained any of the biological activity of intact fenugreek.

Brief Description of the Figures

Figure 1 is a graph showing the cholesterol binding ability of various grind sizes of the fenugreek seed material. The data is expressed as a percentage of unbound cholesterol. The grind sizes used were fine, coarse and intermediate-coarse. The lane marked control contained no fenugreek seed material.

Figure 2 is a graph showing the slipperiness of a solution mixed with various grind sizes of the fenugreek seed material. The grind sizes used were fine, coarse and intermediate-coarse.

Figure 3 is a graph showing the viscosity of a solution mixed with various grind sizes of the fenugreek seed material. The grind sizes used were fine, coarse and intermediate-coarse.

Summary of the Invention

Although many prior art references disclose methods of preparing extracts of fenugreek, none of the methods produce a fenugreek extract which has a substantially reduced taste and odor versus flaked or ground fenugreek seeds, but which maintains all of the biological activity of intact fenugreek resulting from the saponins, the gum, and various other active components in fenugreek seeds.

The present invention includes methods and products relating to a novel fenugreek preparation having substantially reduced taste and odor compared to ground fenugreek seeds but which maintains all of the pharmaceutical properties of an intact fenugreek seed. The methods of the invention relate to methods of using the fenugreek seed material to reduce the intestinal absorption of a caloric compound from a comestible product or to reduce the intestinal absorption of cholesterol from a cholesterol containing comestible product in a human. Other methods according to the invention are methods for reducing cholesterol in a comestible product. The products of the invention relate to the fenugreek seed material. The fenugreek seed material may be formulated as a powder, gel, solid, or liquid for use alone or in combination with a food or drink product.

Prior to the present invention it was known that natural fenugreek seeds exhibited a variety of medicinal functions when administered with food products, such as reducing the amount of intestinal absorption of glucose and cholesterol from the food product. Although it is desirable to mix fenugreek seeds with food and drink products to reduce the intestinal absorption of glucose and cholesterol, the strong odor and taste of fenugreek seeds limit this utility to foods having compatible odor and taste to that of fenugreek, such as foods commonly mixed with curry spice. Additionally the strong odor of fenugreek is processed in the body in such a manner that it causes a human to which the fenugreek was administered to smell like fenugreek because certain molecules within fenugreek are excreted in urine and sweat. The fenugreek seed material of the present invention is an improvement over natural fenugreek and other prior art fenugreek extracts because the fenugreek seed material of the invention has substantially reduced odor and taste compared to these products and can be mixed with any type of food or drink product or

administered to a human without causing the odor problems associated with native fenugreek and maintains the biological activity of native fenugreek.

According to one aspect of the invention an article of manufacture is provided. The article of manufacture is a flaked or ground, alcohol-extracted fenugreek seed material containing at least 80% of the carbohydrate components present in fenugreek seeds and less than 20% of the fat components present in fenugreek seeds and having substantially reduced taste and odor versus flaked or ground fenugreek seeds. In one embodiment the fenugreek seed material is methanol extracted and the resultant fenugreek seed material has less than 50 parts per million of methanol. According to another embodiment, the fenugreek seed material is methanol extracted by a counter current extraction procedure at a temperature of less than 60°C, and preferably less than 55°C. In another embodiment the fenugreek seed material* has the following components in the following proportions:

protein	20-40%
carbohydrate	40-70%
ash	2-5%
fat	<1%.

*1-10% of the fenugreek seed material may be moisture

Saponins are included within the carbohydrate or lipid portion of the fenugreek seed material depending on assaying technique.

In another aspect the invention is a fenugreek seed material having at least 50% of the protein components present in fenugreek seeds, at least 80% of the carbohydrate components present in fenugreek seeds, at least 50% of the ash components present in fenugreek seeds, and less than 20% of the fat components present in fenugreek seeds. The fenugreek seed material has substantially reduced taste and odor versus flaked or ground fenugreek seeds.

According to another aspect of the invention a fenugreek seed material is provided. The fenugreek seed material is a flaked or ground fenugreek seed material having an OD390 value that is 20% less than native fenugreek when mixed in ethanol at 20°-22°C for three hours, centrifuged, and the supernatant measured in a spectrometer. In a preferred embodiment the fenugreek seed material has an OD390 value of 60-70% less than native fenugreek. In a more preferred embodiment the fenugreek seed material has an OD390 value of 80% less than native fenugreek. In a more preferred embodiment the fenugreek seed material has an OD390 value of 90% less than native fenugreek.

According to another aspect of the invention a composition is provided. The composition is a fenugreek seed material formulated as a fenugreek powder having substantially reduced taste and odor versus flaked or ground fenugreek seeds. The fenugreek powder includes at least 80% of active components including protein, saponin, and carbohydrate found in an unmodified fenugreek. In one embodiment the composition also includes at least one capsule containing the fenugreek powder for storage and administration of the fenugreek powder. In another embodiment the fenugreek powder is in at least one capsule in an amount effective for reducing the intestinal absorption of a caloric compound selected from the group consisting of a lipid, a protein, a carbohydrate and a cholesterol. According to another embodiment of the invention the composition includes a comestible, wherein the fenugreek powder is mixed with the comestible. In yet another embodiment of the invention the fenugreek powder has 10% or less of the odor and/or taste of native fenugreek based on the average organoleptic taste and/or odor detection thresholds for the fenugreek seed material and native fenugreek.

In another aspect of the invention an alcohol extracted fenugreek seed material is provided. The alcohol extracted fenugreek seed material is produced by the steps of: flaking a fenugreek seed to form a fenugreek preparation; extracting soluble components from the fenugreek preparation by extraction of the fenugreek preparation with an alcohol solvent at a cool extraction temperature to produce a fenugreek solid; treating the fenugreek solid to remove the alcohol solvent to produce a dry solid; and, grinding the dry solid into a powder to produce a fenugreek seed material. In one embodiment the fenugreek preparation is extracted by a counter current extraction procedure. Preferably the counter current extraction is performed in an extractor which is either a Crown Continuous Loop Shallow Bed Extractor or a French Extractor. In another preferred embodiment the alcohol solvent used to extract the soluble components from the fenugreek preparation is methanol. According to another embodiment the alcohol solvent used to extract the soluble components from the fenugreek preparation is about 10% ethanol and 90% methanol. In another embodiment the method includes the step of mixing the fenugreek seed material with an aqueous solution to produce a fenugreek gel. Preferably the aqueous solution in which the fenugreek seed material is mixed has a pH of between 3.5 and 7. In another preferred embodiment the aqueous solution in which the fenugreek seed material is mixed has a salt concentration of less than 0.01%. According to yet another embodiment of the invention an ethanol supernatant of the fenugreek seed material has a spectrometric value of 60-70% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek

seeds.

According to one embodiment a powder composition is provided. Preferably the fenugreek seed powder is prepared by grinding in standard grinding equipment to produce a powder having an intermediate-course particle size such that approximately 85% of the material passes through a size 80 mesh.

According to one embodiment of the invention a gel composition is provided. The gel composition is a formulation of the fenugreek seed material of the invention having a fenugreek seed material concentration of between 0.05 and 0.2 grams/milliliter of aqueous solution. In one embodiment the fenugreek gel has a pH of between 3.5 and 7. In another embodiment the fenugreek gel has a salt concentration of less than 0.01%. According to another embodiment the gel composition includes a carrageenan based gelatin wherein the fenugreek gel is immersed in the carrageenan based gelatin. The fenugreek gel may be substantially homogeneously dispersed throughout or may be present in clumps within the carrageenan based gelatin. In another embodiment the fenugreek gel is mixed with a comestible to produce a fenugreek-comestible product. According to yet another embodiment the fenugreek gel contains between 5 and 15 g of the fenugreek powder.

According to one embodiment of the invention a liquid composition is provided. The liquid composition is a formulation of the fenugreek seed material of the invention having a fenugreek seed material concentration of more than 0.002 and less than 0.05 grams/milliliter of aqueous solution. In one embodiment the fenugreek liquid has a pH of between 3.5 and 7. In another embodiment the fenugreek liquid has a salt concentration of less than 0.01%. According to another embodiment the fenugreek liquid is mixed with a comestible. In yet another embodiment the fenugreek liquid contains between 5 and 15 grams of the fenugreek powder.

In one embodiment a composition for treating a diabetic is provided. The composition includes the fenugreek seed material of the invention and a hypoglycemic agent. In one embodiment the hypoglycemic agent is selected from the group consisting of insulin, sulfonylureas, metaformin and acarbose.

According to another embodiment a composition is provided. The composition includes the fenugreek seed material of the invention and a hypocholesteremic agent. In one embodiment the hypocholesteremic agent is an HMG-coenzyme reductase inhibitor.

In yet another aspect of the invention a method for reducing the intestinal absorption of a caloric compound from a comestible product in a human is provided. The method includes the

step of orally delivering a fenugreek seed material having at least 50% of the protein components present in fenugreek seeds, at least 80% of the carbohydrate components present in fenugreek seeds, at least 50% of the ash components present in fenugreek seeds, and less than 20% of the fat components present in fenugreek seeds and having a substantially reduced taste and odor versus flaked or ground fenugreek seeds, and a comestible product to the human.

According to another aspect of the invention a method for reducing the intestinal absorption of cholesterol from a cholesterol containing comestible product in a human is provided. The method includes the step of orally delivering a fenugreek seed material having at least 50% of the protein components present in fenugreek seeds, at least 80% of the carbohydrate components present in fenugreek seeds, at least 50% of the ash components present in fenugreek seeds, and less than 20% of the fat components present in fenugreek seeds and having a substantially reduced taste and odor versus flaked or ground fenugreek seeds, and a cholesterol containing comestible product to the human. In one embodiment the fenugreek seed material is formulated as a gel having a fenugreek seed material concentration of 0.05-0.2 grams/milliliter and containing between 5 and 15 grams of the fenugreek seed material. Preferably the gel is delivered less than 30 minutes before the comestible product. According to another embodiment the fenugreek seed material is formulated as a liquid having a fenugreek seed material concentration of more than 0.002 and less than 0.05 grams/milliliter and containing between 5 and 15 grams of the fenugreek seed material. Preferably the liquid is delivered less than 30 minutes before the comestible product. In yet another embodiment the caloric compound is selected from the group consisting of a lipid, a protein, and a carbohydrate. According to another embodiment the fenugreek seed material is a flaked or ground fenugreek seed material having an OD390 value of 20% less than native fenugreek when mixed for three hours in ethanol and the supernatant is measured in a spectrometer. In a preferred embodiment the fenugreek seed material has an OD390 value of 60-70% less than native fenugreek. In a more preferred embodiment the fenugreek seed material has an OD390 value of 80% less than native fenugreek. In a more preferred embodiment the fenugreek seed material has an OD390 value of 90% less than native fenugreek. According to one embodiment the fenugreek seed material has an OD390 value of 88% less than native fenugreek when dissolved in ethanol for three hours and measured in a spectrometer.

According to yet another aspect of the invention a method for reducing cholesterol in a comestible product is provided. The method includes the steps of mixing a fenugreek seed

material having at least 50% of the protein components present in fenugreek seeds, at least 80% of the carbohydrate components present in fenugreek seeds, at least 50% of the ash components present in fenugreek seeds, and less than 20% of the fat components present in fenugreek seeds and wherein the fenugreek seed material has substantially reduced taste and odor versus flaked or ground fenugreek seeds, with a cholesterol containing comestible product to produce a fenugreek comestible mixture; mixing the fenugreek comestible mixture to separate the fenugreek comestible mixture into a fenugreek-cholesterol containing solution and a cholesterol free comestible solution; and, isolating the cholesterol free comestible solution. According to another embodiment the fenugreek seed material is a flaked or ground fenugreek seed material having an OD390 value of 20% less than native fenugreek when mixed for three hours in ethanol and the supernatant is measured in a spectrometer. In a preferred embodiment the fenugreek seed material has an OD390 value of 60-70% less than native fenugreek. In a more preferred embodiment the fenugreek seed material has an OD390 value of 80% less than native fenugreek. In a more preferred embodiment the fenugreek seed material has an OD390 value of 90% less than native fenugreek.

The invention also includes a method of preparing an alcohol extracted fenugreek seed material. The method involves the steps of flaking a fenugreek seed to form a fenugreek preparation. Soluble components are extracted from the fenugreek preparation with an alcohol solvent at a cool extraction temperature to produce a fenugreek solid. The fenugreek solid is treated to remove the alcohol solvent to produce a dry solid. The dry solid is then ground into a powder to produce the fenugreek seed material.

In one embodiment, the cool extraction temperature is between 30° C and 60°C. In a preferred embodiment, the cool extraction temperature is between 40°C and 55°C. In another preferred embodiment, the cool extraction temperature is 52°C.

The extraction step can be carried out using a countercurrent extraction. The countercurrent extraction procedure preferably may be performed in a Crown continuous loop extractor shallow bed extractor or a French extractor. Preferably the extractor is a Crown extractor.

The fenugreek preparation is extracted with an alcohol solvent. Preferably the alcohol solvent is methanol. In another embodiment, the alcohol solvent is about 10% ethanol and 90% methanol.

According to yet another embodiment of the invention, the fenugreek solid is treated to

remove the alcohol solvent by the steps of desolventization, solvent wash, and drying. The step of desolventization can be performed in a desolventizer toaster. When the solvent is methanol, the solvent wash can be a series of ethanol washes such that the methanol is removed by the ethanol washes to produce a dry solid which has less than 100 parts per million of methanol. The drying step can be performed in a tumble dryer.

The fenugreek extract produced according to the method of the invention has a substantially reduced taste and odor versus flaked or ground fenugreek seeds. The alcohol extracted fenugreek seed material includes the essential biologically active components of intact fenugreek seeds, such as protein, carbohydrate, and saponins.

Detailed Description Of The Invention

For many years, fenugreek seeds have been used in food products and herbal medicaments. Due to the strong odor and taste of fenugreek, however, their use in the preparation of modern medicines and other therapeutic modalities has been limited. Many researchers have attempted to isolate the active components of fenugreek in order to prepare compositions which have the biological activity of fenugreek. None of these attempts, however, has resulted in the preparation of a fenugreek seed material having substantially reduced taste and odor compared to intact fenugreek seeds, but which also maintain a significant proportion of the carbohydrate, protein, and saponin material of fenugreek and thus the biological activity of native fenugreek.

The invention provides novel preparations of fenugreek seed material having substantially reduced taste and odor versus native fenugreek seeds. Although the fenugreek seed materials of the invention have reduced taste and odor, the materials have all of the biological activity of native fenugreek. The fenugreek preparations of the invention may be used for all of the same indications that native fenugreek is used for, except as a spice or flavoring agent. The invention also encompasses methods of using the fenugreek preparation. According to the methods of the invention the fenugreek preparation may be used for reducing caloric and/or cholesterol absorption from a food product.

The fenugreek preparations of the invention are composed of a fenugreek seed material. "Fenugreek seed material" as used herein is an extract of fenugreek seeds having the biological activity of native fenugreek but having substantially reduced taste and odor versus native fenugreek seeds. An extract which "has the biological activity of native fenugreek" is an extract which has at least a hypocholesteremic and hypoglycemic activity. Fenugreek seeds are

produced by the leguminous herb of the family papilionaceae trifolieae, and genus trigonella which is grown predominantly in Northern Africa, the Middle East, and Asia. Fenugreek seeds are readily available from a wide variety of commercial sources, such as Morris J. Golombeck (Brooklyn, NY) or Dirigo Spices (Boston MA). Fenugreek seeds useful for preparing the fenugreek seed material of the invention may be obtained from any source.

The fenugreek seed material has substantially reduced taste and odor versus native fenugreek. According to the invention, a fenugreek seed material which has substantially reduced taste and odor is one having 10% or less of the odor and/or taste of native fenugreek based on the average organoleptic taste and/or odor detection thresholds for the fenugreek seed material and native fenugreek. Preferably the fenugreek seed material has 5% or less of the odor and/or taste of native fenugreek based on the average organoleptic taste and/or odor detection thresholds. Most preferably it has 2% or less of the odor and/or taste of native fenugreek based on the average organoleptic taste and/or odor detection thresholds.

The following organoleptic evaluation methods for quantitatively or qualitatively measuring odor and taste are useful for determining whether a fenugreek seed material has substantially reduced odor and taste according to the invention.

Rapid Organoleptic Ethanol Extraction Test: An equal volume of the test sample fenugreek seed material and control ground fenugreek seeds are each added to a solution of ethanol at approximately 10% w/v. The solutions are incubated at room temperature with intermittent vortexing for three hours. The solutions are then centrifuged to pellet the solid material. A one milliliter extract of each solution is removed and analyzed in a spectrometer at OD390. The absorbance reading for the native fenugreek seed typically is over 0.400 OD units, and the absorbance reading of material prepared according to the methods described below is typically between 0.030 and 0.080 OD Units.

In one aspect of the invention the fenugreek seed material is a fenugreek seed material, flaked or ground, having an OD390 value of 20% less than native fenugreek when mixed for three hours in ethanol and the supernatant is measured in a spectrometer. In a preferred embodiment the fenugreek seed material has an OD390 value of 60-70% less than native fenugreek. In a more preferred embodiment the fenugreek seed material has an OD390 value of 80% less than native fenugreek. In a more preferred embodiment the fenugreek seed material has an OD390 value of 90% less than native fenugreek.

Average Organoleptic Taste and/or Odor Detection Threshold Evaluation Method:

As used herein, the "average organoleptic taste and/or odor detection threshold evaluation" is a measure for assessing the relative amount of taste and/or odor which has been removed from a fenugreek material. The relative amount of taste and/or odor removed is quantified as a threshold concentration required for an average group of persons to taste and/or smell a test fenugreek material as compared to that amount required to taste and/or smell the same concentration of native fenugreek.

A working example of an average organoleptic taste and/or odor detection threshold evaluation analysis is provided in the Examples below. Briefly, various quantities of the fenugreek seed material or native fenugreek are added to 50 ml of deionized water in plastic tubes. Prior to each testing, the tubes are shaken for a few seconds by hand and a cotton swab is dipped into the various solutions. The subject to be tested is then given the swab to taste to determine if any taste is detected. The solutions are tested in increasing concentration of fenugreek beginning with a control tube containing deionized water only. The order of testing between fenugreek seed material and native fenugreek is randomized between subjects. All testing is conducted by a single tester. A threshold concentration at which a subject can detect a taste is established for each subject.

Quantitative Organoleptic Evaluation Method: The organoleptic evaluation method described in US Patent No. 4,356,190, which is hereby incorporated by reference, provides a method for quantitatively evaluating the odor intensity of a sample as an absolute value. This provides a quantitative description of the odor intensities between different samples. The method may also be used to evaluate the taste of a fenugreek sample. Although the organoleptic evaluation method described in 4,356,190 does not specifically contemplate a comparison of the odor and taste of fenugreek samples, the method is described briefly below with reference to analysis of a fenugreek sample.

Initially, the threshold concentration of a sample odor is established by the method described in *Steiger, F.H., Chemical Technology,* V.1. P.225 (1971). Briefly, a panel of subjects is presented with a series of samples containing native ground fenugreek seeds in water in increasing concentrations. The panelists are presented the fenugreek samples in a jar in order of increasing concentration with the first sample at zero concentration (water only). They are then asked to identify the first sample having a detectable odor. The accumulated data is plotted as described in the Steiger article in order to determine the concentration level of which an arbitrary percentage of the panelists can detect the odor. The concentration at 50% is taken as the

threshold concentration.

A master fenugreek curve is prepared by presenting a panel of subjects a series of fenugreek samples prepared at concentrations which are various multiples of the threshold concentration (and referred to as odor units). The fenugreek samples are prepared by mixing various quantities of ground fenugreek in 3 ml of water and incubating for one hour. Each panelist is asked to evaluate the set of samples assigning each sample a value between 0 and 20 correlating to the odor intensity of the sample. The data is then organized with each sample corresponding to a specific multiple of the threshold concentration such that the sample twenty times the threshold concentration is assigned a value of one hundred and the threshold sample is assigned a value of zero. The data is obtained as a series of ratio values corresponding to each sample. The mean of the ratio values for each sample (based on multiple subjects) is calculated and is taken as the ratio value for that multiple of threshold concentration. The log of the ratio value is plotted, as the ordinate, against the log of the multiple of threshold concentration for the fenugreek samples and a straight line is fitted to the data points between three and twenty times threshold concentration to produce the master fenugreek curve.

The master fenugreek curve can be used to evaluate the odor intensity of any fenugreek seed test sample to determine whether the preparation has a substantially reduced odor intensity. In order to accomplish this, a panel is presented with a series of samples, one of which is a standard native ground fenugreek sample consisting of a known concentration of fenugreek being tested in an environment identical to that used in producing the master curve. Preferably the standard sample is twenty times the threshold concentration so that it has a ratio value of one hundred on the master curve. Alternatively three standard samples are used having three, ten and twenty times the threshold concentration and thus having a ratio value of fifteen, fifty, and one hundred on the master curve. Panelists are asked to evaluate the series of fenugreek seed test samples at various concentrations at the same time as evaluating the standard native ground fenugreek samples and to assign an odor intensity value to each sample (test samples and standard samples) based on the scale. The mean of the values assigned by the panelists can then be assigned an odor intensity by matching the mean ratio value to the master curve. A fenugreek seed material having substantially reduced odor according to the invention is one having a ratio value of less than or equal to 50 when evaluated by the modified ratio scale organoleptic evaluation method and the sample is prepared at a concentration equivalent to the fenugreek concentration which is twenty times the threshold concentration. This sample is said to have at

least 50% less odor intensity than native fenugreek. Preferably the fenugreek seed material of the invention has a ratio value of less than or equal to 25 when evaluated by the modified ratio scale organoleptic evaluation method and the sample is prepared at a concentration equivalent to the fenugreek concentration which is twenty times the threshold concentration. This sample is said to have at least 75% less odor intensity than native fenugreek. Most preferably the ratio value is less than or equal to 10. This sample is said to have at least 90% less odor intensity than native fenugreek.

The above described assays are provided for exemplary purposes only. Any assay ordinarily used in the art may be sufficient to determine whether the fenugreek seed material has substantially reduced odor and taste compared to fenugreek. Other assays for measuring and comparing the odor and taste of different compounds which are useful for determining whether the fenugreek seed material has a substantially reduced taste with respect to fenugreek are disclosed in US Patent Nos. 4,381,402, 4,180,589, 5,482,855 and 5,571,519, each of which is hereby incorporated by reference.

Native fenugreek seeds are ordinarily composed of approximately 50-70% carbohydrate, 1-5 % ash, 15-30 % protein, 1-10% fat, and 1-10% moisture. Saponins are included within the carbohydrate or lipid portion of the fenugreek seed material depending on assaying technique. The fenugreek seed material of the invention has altered concentrations of fenugreek components than native fenugreek but retains enough of the components to maintain all of the biological activity of native fenugreek. For instance, in one embodiment, the fenugreek seed material includes at least 50% of the protein components present in fenugreek seeds, at least 80% of the carbohydrate components present in fenugreek seeds, at least 50% of the ash components present in fenugreek seeds but has less than 20% of the fat components present in native fenugreek seeds. In another embodiment the fenugreek seed material is formulated as a fenugreek powder and includes at least 80% of the active components found in unmodified fenugreek. The active components are protein, saponins, and carbohydrates including fiber. In another embodiment the fenugreek seed material is an alcohol-extracted fenugreek seed material containing at least eighty percent of the carbohydrate components present in fenugreek seeds and less than twenty percent of the fat components present in fenugreek seeds. Preferably the flaked or ground alcohol extracted fenugreek seed material is composed of 20-40% protein, 40-70% carbohydrate, 2-5% ash, less than 1% fat, and 1-10% moisture. Carbohydrate as used herein includes both soluble and insoluble crude fibers as well as other types of carbohydrates ordinarily found in fenugreek

seeds.

In one aspect the fenugreek seed material is an alcohol-extracted fenugreek seed material. The alcohol extracted fenugreek seed material is produced by the steps of flaking a fenugreek seed to form a fenugreek preparation, extracting soluble components from the fenugreek preparation by extraction of the fenugreek preparation with an alcohol solvent at a cool extraction temperature to produce a fenugreek solid, treating a fenugreek solid to remove the alcohol solvent to produce a dry solid, and grinding the dry solid into a powder to produce the fenugreek seed material.

The fenugreek seed material may be prepared by an alcohol extraction of fenugreek seeds, to produce the fenugreek seed material having substantially reduced taste and odor versus native fenugreek. For example, native fenugreek seeds may be flaked or ground and extracted with methanol to produce a fenugreek solid which can be ground into a powder to produce the fenugreek seed material. Other straight chain lower alcohols may be used in place of methanol (e.g., ethanol). As will be understood by one of ordinary skill in the art, multiple alcohol extractions may be performed to further refine the fenugreek material. One of skill in the art can easily determine whether the fenugreek seed material has been sufficiently extracted by the Rapid Organoleptic Ethanol Extraction Test discussed above.

Briefly, an equal volume of ground fenugreek seed test sample are added to a solution of ethanol at approximately 10% w/v. For comparison purposes native ground fenugreek seeds are added to a solution of ethanol at approximately 10% w/v. The solutions are incubated at room temperature with intermittent vortexing for three hours. The solutions are then centrifuged to pellet the solid material. A one milliliter extract of each solution is removed and analyzed in a spectrometer at OD390. The absorbance reading for the native fenugreek seed typically is over 0.400 OD units. An absorbance reading for a fenugreek seed material under the same conditions as the native fenugreek is generally on the order of approximately 0.003-0.080 OD Units. When the fenugreek seed test sample has an OD390 value of 20% less than native fenugreek the extraction steps were sufficient to produce the fenugreek seed material of the invention. Preferably the fenugreek seed material has an OD390 value of 60-70% less than native fenugreek. More preferably the fenugreek seed material has an OD390 value of 80% less than native fenugreek. More preferably the fenugreek seed material has an OD390 value of 90% less than native fenugreek.

Indeed, as will be understood by one of ordinary skill in the art, the fenugreek seed

material produced by the alcohol extraction method may be further purified and refined by a variety of fractionation and separation techniques (e.g., chromatography, dialysis, filtration, electrophoresis) as long as the biological activity of the fenugreek seed material is not altered by the purification steps. After such fractionation or separation steps, one may, without undue experimentation, perform the assays discussed below in the Examples section to determine whether the preparation maintains the biological activity of native fenugreek. Any such preparation constitutes a "fenugreek seed material" as used herein and in the appended claims.

The following example of a procedure for preparing the fenugreek seed material of the invention is provided for illustrative purposes only. Native fenugreek seeds are flaked to form a fenugreek preparation. The seed is flaked in order to expose a larger surface area for the subsequent solvent extraction step. The step of flaking which is commonly used in the preparation of grain for animal feeds is preferably accomplished using a commercially available flaking mill. For example, the flaking mill produced by the Simon-Day (Sandvik Process System, Canada) is useful according to the invention. Other flaking mills have been described extensively in the prior art (e.g., U.S. Patent Nos. 5,386,946; 3,881,663, etc.).

Soluble components are extracted from the flaked fenugreek preparation with an alcohol solvent at a cool extraction temperature to produce a fenugreek solid. Although various extraction methods are feasible, a continuous countercurrent extraction procedure is preferred. Countercurrent extractors are commonly used in the food processing industry for the continuous extraction of liquids, solubles, and fine particulate matter from solid material. Typically in a countercurrent extractor, material to be processed is fed into the lower end of a housing and carried upwards, while an extracting liquid which is fed into the top of the housing flows downward under gravity. The material to be processed is generally carried upwards within the extractor by a screw rotation. More advanced types of continuous countercurrent extractors, such as the Crown model II continuous loop, shallow bed extractor (Crown Works Company, Minneapolis, Minnesota) produce highly efficient extraction steps. In an advanced extractor such as the Crown model, the fenugreek preparation is fed onto a conveyor chain in the extractor which carries the preparation around a vertical loop. An alcohol solvent is fed into the loop in a direction opposite of the fenugreek preparation. The speed at which the fenugreek preparation is moved through the extractor loop is controlled electronically to conform to the input of raw material in order to maintain a uniform density and depth relative to the preparation.

The solvent suitable for use in the extraction procedure is an alcohol solvent. As used

herein, "an alcohol solvent" is any solvent which is made up of a single straight chain alcohol or combination of more than one type of alcohol. Preferred alcohol solvents of the invention are methanol, ethanol, or a combination of ethanol and methanol. Solvents traditionally used for extraction procedures, such as hexane and isopropanol, are not useful in the method of the present invention.

The amount of solvent useful in the extraction procedure is any amount which results in the extraction of soluble components of the fenugreek solid. Preferably the amount of solvent used is sufficient to extract the maximum amount of soluble components. A weight ratio of alcohol solvent to fenugreek solid which is sufficient to extract a maximum amount of soluble components is 10 (alcohol):1 (fenugreek) -3 (alcohol):1 (fenugreek). In one embodiment the weight ratio is 5 (alcohol):1 (fenugreek).

The extraction steps can also be accomplished in more than one extraction, i.e., the fenugreek preparation can undergo several extractions with fresh solvent in order to insure more complete removal of the soluble components. For example, a first extraction may leave significant amount of the soluble components in the fenugreek preparation. More of the soluble components can be extracted by at least one additional extraction with fresh solvents.

The extraction procedure is performed at a cool extraction temperature. A "cool extraction temperature" as used herein is a temperature between 30°C and 60°C. Ordinarily, extraction temperatures are greater than 80°C. In a preferred embodiment, the cool extraction temperature is less than 55°C. In a particularly preferred embodiment, the cool extraction temperature is 52°C. The cool extraction temperature is believed to prevent the reintroduction of the bitter flavor into the fenugreek material.

The fenugreek solid which remains after the extraction step is treated to remove the alcohol solvent to produce a dry, solid material. The treatment of the fenugreek solid includes the steps of desolventizing, solvent wash, and drying.

The step of desolventization involves a combination of heat and vacuum to evaporate the extraction solvent. Methods for desolventizing seed material are well known in the art (e.g., U.S. Patent No. 4,376,073 and U.S. Patent No. 4,622,760). Preferably the desolventization step is performed in a desolventizer toaster, such as the one manufactured by Crown Iron Works (Minneapolis, Minnesota). Alternatively, a sparse steaming alternative desolventization step may be performed.

A "solvent wash" as used herein is a series of solubilization washes to solubilize and

remove the alcohol solvent. When the alcohol solvent is methanol, the first of the series of solvent washes is preferably 100% ethanol. The subsequent washes are preferably 50% ethanol and 50% water. Any apparatus commonly used for solvent washing may be used for the solvent wash step. A decanter centrifuge may be used to recover the ethanol and the ethanol may be recycled. In another embodiment, the solvent wash solution is added at a ratio of 3:1 solvent to fenugreek solid (w/w).

The desolventized fenugreek material is tumble dried. "Tumble dried" as used herein refers to a process involving vacuum, heat, and movement of the fenugreek material to ensure an even and thorough drying of the material. Movement of the fenugreek material is important. Stationary dryers, such as a fluid bed dryer and a desolventizer toaster, are not well suited to achieve a complete removal of the alcohol solvent without burning the fenugreek material. Tumble dryers are commercially available by various suppliers such as Patterson Ind. Canada, Ltd. Once the fenugreek solid has been treated to produce a dry solid, the material may be ground into a powder to produce the finished fenugreek seed material product.

The fenugreek seed material of the invention may be formulated by any manner known in the art. For instance, the fenugreek seed material may be formulated as a powder. As used herein a "fenugreek powder" is a ground composition of the fenugreek seed material of the invention. Preferably the material is ground to an intermediate-course size. Surprisingly, a fenugreek powder having a particle distribution mesh size of -80 was found to produce an optimal fenugreek seed material. Ordinarily it is believed that a finer grind material will have greater binding capacity than a course grind because of its greater surface area. As demonstrated in Example 5 it was discovered according to the invention that fenugreek seed material that is ground to an intermediate-course size has better cholesterol binding capacity and reduces post prandial glucose more effectively than the same material ground to a fine powder or ground to a course material.

The powder can be administered directly to a human subject or may be mixed with a comestible product such as a food or drink product just prior to the ingestion of that comestible product by the human subject. The powder may also be used in the preparation of a food or drink product which may be stored prior to consumption. The powder may be stored in any type of container either alone or combined with a food or drink product. For example the powder may be stored in plastic or glass bottles or jars, vials, bags, boxes, or capsules.

The fenugreek seed material may also be formulated as a solid material. A fenugreek

solid material is a composition of the fenugreek seed material of the invention which may or may not be ground. The fenugreek solid material may be consumed as a solid material by a human subject or may be ground to produce a fenugreek powder. Alternatively the solid material may be mixed with a comestible product and/or formulated into a comestible product. For example, the fenugreek solid material may be formulated into tablets which may be administered to human subjects prior to or in conjunction with a meal.

Alternatively, the fenugreek seed material may be formulated as a fenugreek gel. A "fenugreek gel" as used herein is a viscous aqueous solution or suspension of the fenugreek seed material of the invention having a concentration of between 0.05 and 0.2 gram fenugreek seed material/ml aqueous solution. The fenugreek gel may be administered directly to a human subject prior to or concurrently with a meal or may be mixed with a comestible product such as a food or drink product just prior to the ingestion of that product by the human subject. The gel may also be used in the preparation of a food or drink product which may be stored prior to consumption. For example the fenugreek gel may be immersed in a carrageenan based gelatin to form a gelatinous product which can be consumed prior to or concurrently with a meal. The fenugreek gel may be dispersed throughout the gelatin to produce a substantially homogenous substance or may be stirred into the gelatin to produce a gelatinous substance having clumps of fenugreek seed material throughout the gelatin. The gel may be stored in any type of container either alone or combined with a food or drink product.

The fenugreek seed material may also be formulated as a fenugreek liquid. The fenugreek liquid is prepared by dissolving a fenugreek seed material in an aqueous solution. A "fenugreek liquid" as used herein is an aqueous solution having a concentration of more than 0.002 and less than 0.05 grams of fenugreek seed material/ml of aqueous solution. Similar to the fenugreek powder, solid, and gel the fenugreek liquid may be administered directly to a human subject prior to or concurrently with a meal or may be mixed with a comestible product just prior to the ingestion of that comestible product by the human subject. The liquid may also be used in the preparation of a comestible product which may be stored prior to consumption. The fenugreek liquid may be stored in any type of container either alone or combined with a comestible product.

The fenugreek liquid and the fenugreek gel are formulated such that they are compatible with a physiological environment. Formulations which are compatible with a physiological environment are well known in the art. In a preferred embodiment the fenugreek gel and the

fenugreek liquid have a pH of between 3.5 and 7.

In a preferred embodiment the fenugreek gel and the fenugreek liquid have a salt concentration of less than 0.01 %.

The fenugreek seed material may be administered alone or in conjunction with other medicinal therapies. For example when the fenugreek seed material is administered to a diabetic patient the patient may also be administered insulin or hypoglycemic agents and when the fenugreek seed material is administered to a hypercholesteremic patient the patient may also be administered a hypocholesteremic agent, such as an HMG-coenzyme reductase inhibitor.

As discussed above, the fenugreek seed material of the invention, formulated as a powder, gel or liquid may be mixed with a comestible to produce a fenugreek comestible product. A comestible as used herein is any type of edible food or drink containing at least one caloric compound and/or a cholesterol compound. For example, comestible products include dairy products such as milk and ice cream, baked goods such as cookies and cakes, gelled desserts, puddings, salad dressings, etc.

The fenugreek seed material may also be mixed with and/or administered with an orally administered medicament. For instance the fenugreek seed material may be mixed with a medicament for treating diabetics, such as insulin, sulfonylureas, metaformin, acarbose, etc. The fenugreek seed material may be mixed with a hypercholesteremic medicament, such as an HMG-coenzyme reductase inhibitor. When the fenugreek seed material is administered with a medicinal, the concentration of the medicinal should be adjusted to account for the change in absorptive properties associated with the fenugreek seed material.

The fenugreek seed material has the biological activity of native fenugreek and therefore is useful for treating all of the indications that native fenugreek is useful for treating. Native fenugreek seeds have been recommended to have both hypoglycemic and hypocholesteremic activity *in vivo*. Fenugreek seeds have also been recommended to have utility in promoting ease of menstruation, alleviating the symptoms of menopause and soothing irritated tissues to help relieve sore throat pain, cough and minor indigestion. The fenugreek seed material of the invention is useful for treating each of these disorders as well as any other disorders for which native fenugreek is known to be useful for treating.

According to methods of the invention, the fenugreek seed material is useful for reducing the intestinal absorption of a caloric and/or cholesterol compound from a caloric and/or cholesterol containing comestible product in a human subject. The fenugreek seed material is

orally delivered to the subject prior to or concurrently with the comestible product.

Although Applicants do not wish to limit the scope of the invention to a particular mechanism, it is believed that the fenugreek seed material forms a viscous mass with the comestible product, slowing down the release of the comestible product from the stomach and the movement of the comestible product through the intestinal tract. The rate at which partially digested food leaves the stomach is inversely proportional to the viscosity of the food. Ordinarily when a comestible product is ingested it is released from the stomach within a narrow time period. As the food travels through the intestinal tract it is broken down and absorbed through the intestinal wall causing a rapid rise in blood glucose. The body responds to the rise in blood glucose by secreting insulin which aids in the conversion of glucose into energy. If more glucose is absorbed from the intestine than the insulin can process then the excess glucose is converted to fat and stored in the body rather than being used for energy. By slowing down the transportation of the comestible product from the stomach and through the intestine the fenugreek seed material of the invention causes a slower glucose absorption rate resulting in a consistent low level of glucose in the blood rather than a rapid rise in glucose level. Because the glucose level is lower, all of the glucose is processed by the insulin rather than being stored as fat.

It is also believed that the fenugreek seed material functions as a surfactant, preventing the absorption of the caloric and/or cholesterol compound. When the fenugreek seed material of the invention is ingested just prior to the caloric and/or cholesterol containing comestible product the fenugreek seed material coats the stomach and intestinal lining and thus blocks the absorption of some of the caloric compounds and cholesterol. The fenugreek seed material also binds to the cholesterol preventing its absorption through the intestinal wall.

The fenugreek seed material of the invention is orally delivered to a human prior to or concurrently with a comestible product. The preferred timing of the delivery of the fenugreek seed material is dependent on the form of the fenugreek seed material being delivered to the human. When the fenugreek seed material is formulated as a powder it is preferably delivered less than 15 minutes prior to the comestible product. When the fenugreek seed material is formulated as a liquid or as a gel it is preferably delivered less than 30 minutes before the comestible product. In a preferred embodiment the fenugreek gel and liquid are administered just prior to or concurrently with the comestible.

The amount of fenugreek seed material delivered to a subject varies depending on how

the fenugreek seed material is formulated. When the fenugreek seed material is formulated as a powder 5-10 grams of the powder is sufficient to provide the hypoglycemic and hypocholesteremic effects of the fenugreek seed material. When the fenugreek seed material is formulated as a gel or liquid approximately 5-15 grams of fenugreek seed material is sufficient to provide the hypoglycemic and hypocholesteremic effects of the fenugreek seed material.

According to another method of the invention the fenugreek seed material is useful for removing cholesterol from a cholesterol containing comestible. The fenugreek seed material absorbs cholesterol thus allowing the cholesterol to be removed from a cholesterol containing comestible. The method involves the step of mixing a cholesterol containing comestible with the fenugreek seed material of the invention and separating the cholesterol absorbed to the fenugreek seed material from the comestible product. The method is particularly useful for removing cholesterol from a liquid cholesterol containing product, such as milk or cream. The fenugreek material is separated from the milk or cream by centrifugation or decanting.

Although the methods of the invention are particularly useful for overweight subjects and subjects having hypercholesteremia, hyperglycemia, a human subject according to the invention includes all humans. A human subject of average weight and having normal cholesterol levels may use the methods of the invention, for instance, as a prophylactic measure in order to prevent the development of hypercholesteremia or weight gain. Although each of the preferred embodiments has been described in relation to human subjects, the methods of the invention are also useful for treating non-human mammals such as dogs and cats.

The following examples are provided to illustrate the methods and products of the present invention. As described above, many variations on these particular examples are possible and, therefore, the examples are merely illustrative and not limiting of the present invention.

Examples

Example 1: A method for preparing an alcohol extracted fenugreek seed material.

Flaking:

Fenugreek seeds obtained from Morris J. Golombeck and Son (Brooklyn, NY) were flaked to create maximally exposed surface area in a flaking mill (V. Simon-Day, Sandvik Process System, Canada). The gap between the rollers of the flaking mill was set at 0.3 mm. The roller speeds were set at 150 and 147 rpm to create a roller differential speed of 3 rpm. The fenugreek seeds, having an optimal moisture content of 9-13%, were fed into the flaking mill at 150-225 kg/hr. When the seeds were tempered to 11% moisture, a sieve analysis of flaked seed

product showed that 91.14% of the flaked seeds were approximately 500 microns in size; 5.05% of the seeds were approximately 350 microns; 1.88% of the seeds were approximately 250 microns; and 1.92% of the seeds were under 250 microns in size.

Solvent Extraction:

The flaked fenugreek seed was solvent extracted in a Crown model II continuous loop shallow bed extractor (Crown Iron Works, Minneapolis, Minnesota). The flaked seed material was fed into the inlet hopper at the top of the extractor a rate of 35-45 kg/hr and onto a conveyor chain which carries the flakes around the vertical loop of the extractor. Virgin methanol was fed into the extractor at a rate of 7.3 liters per minute and was washed over the surface of the flakes as the flakes were conveyed through the extractor. The solvent moves through the extractor in a path countercurrent to the flow of the flakes. The bed retention time was 132 minutes and the average temperature of the fresh solvent was 46°C. After the final fresh solvent rinses, the flakes were conveyed over a drainage area and discharged in a semi-dry condition.

Desolventizing:

The semi-dry flakes were transferred from the extractor to a desolventizer toaster (Crown Iron Works, Minneapolis, Minnesota). The conveyor temperature was 57.5°C. Once the flakes were conveyed into the toaster, steam was released from the top tray at a pressure of 29 psi and at a sparge steam rate of 2-3 kg/hr. The average temperature at the top of the tray was 60°C and at the bottom of the tray was 59°C. After thirty minutes, the flakes were removed from the toaster.

Ethanol Wash:

The fenugreek material was transferred to a 2600 liter reactor which was 1.52 m in diameter and 1.88 m in height. 95% ethanol was then added to the reactor at a fenugreek to ethanol ratio of 1:3 (w/w) at room temperature. The mixture was agitated at 155 rpm with a dual prop with mechanical variable speed drive (7.5 horsepower; 3 phase, 575 volt, 1725 rpm) and the temperature was raised to 40°C. The bottom jacket steam pressure was 8.0-8.5 psi. After eight hours of agitation at 40°C, the slurry was fed into to a decanter centrifuge at a rate of 1200 kg/hr (Westfalia Separator, A.G., Germany). The bowl speed was 5200 rpm and the centrifugal force was 3245 x g. The ethanol was recovered and the fenugreek material was transferred to a jacketed tank capable of holding 2600 liters and 1.23 m in diameter and 2.20m in height. 50% ethanol was added to the jacketed tank at a fenugreek to ethanol ratio of 1:3 (w/w). The temperature of the mixture was raised from room temperature to 40°C and was agitated at 40°C for 3.5 hours. Again, the washed fenugreek material was transferred to a decanter centrifuge at a

rate of 500 kg/hr at 40°C to separate the extracted fenugreek material from the ethanol. The differential speed of the centrifuge was 52 rpm and the screw back pressure was 30.

Tumble Dry:

After the second ethanol wash, the level of the methanol in the fenugreek was substantially reduced. In order to remove any remaining methanol and to dry the material, 100-145 kg of fenugreek material was transferred to a 19.6 cubic foot tumble dryer (Patterson Ind. Canada, Ltd.). The moisture of the fenugreek material was reduced from 50.9% to 3-5% in 5 - 7.5 hours. The chamber temperature of the tumble dryer was 60-65°, the jacket temperature was 60-100°C, the vacuum was 26-28; and the speed was 50% of maximum.

Grind:

The dry fenugreek material was commercially micronized to produce two finished powders identified as "Coarse" and "Fine" having the following particle size distributions -80 mesh, -100 mesh, -140 mesh, and -200 mesh. Several commercial processing companies, such as PowderSize (Quaker Town PA), which are licensed by the FDA can prepare food grade powders to make-to-order particle size specifications. The dry fenugreek material was micronized in this instance by PowderSize using proprietary air jet milling equipment (PowderSize, Quaker Town PA). The micronized particles were isolated in a product separator, and placed in finished bulk containers.

Example 2: Analysis of the Components of the Alcohol Extracted Fenugreek Seed Material(RHUBICINE™).

A chemical analysis on both the alcohol extracted fenugreek seed material (this material will be referred to in the Examples hereafter as RHUBICINE™) and native fenugreek was performed commercially by Nutrition International Laboratories, Inc. (Dayton NJ) to determine the amount of moisture, protein, fat, carbohydrate, soluble dietary fiber, insoluble dietary fiber, and ash content using routine chemical procedures. The results are shown in Table 1.

TABLE 1

Component	RHUBICINE™	Native Fenugreek
Moisture	6.55%	7.44%
Protein	33.5%	27.56%
Fat	0.67%	5.76%
Ash	2.85%	3.14%

TABLE 1		
Total Carbohydrate (Fiber)	56.43%	56.10%
Soluble Dietary Fiber	15.8	26.3
Insoluble Dietary Fiber	42.8	27.74

Example 3: Odor and Taste Analysis of RHUBICINE™.

In this assay 1.0 gram of RHUBICINE™ or 1.0 gram of ground native fenugreek was added to 10.0 ml of ethanol in a 15 ml plastic centrifuge tube and rocked continuously at room temperature for three hours. At that time a 1 ml aliquot of the mixture was placed into a microcentrifuge tube and centrifuged in a Beckman Microfuge. The OD390 of the supernatant was measured in a Hitachi U-2000 spectrophotometer.

The OD390 of the RHUBICINE™ had an OD390 value of 87% less than the OD390 value of native fenugreek. The results are shown in Table 2.

Table 2	
Native Fenugreek	0.420
RHUBICINE™	0.054

Example 4: Measurement of the Average Organoleptic Taste Detection Thresholds for the RHUBICINE™ and Native Fenugreek.

Various quantities of RHUBICINE™ or native fenugreek were added to 50 ml of deionized water in plastic tubes. Prior to each testing, the tubes were shaken for a few seconds by hand and a cotton swab was dipped into the various solutions. The subject to be tested was then given the swab to taste to determine if any taste was detected. The fifty subjects used in the test were healthy individuals between the ages of 21 and 60. The solutions were tested in increasing concentration of fenugreek beginning with a control tube containing deionized water only. The order of testing between RHUBICINE™ and native fenugreek was randomized between subjects. All testing was conducted by a single tester. A threshold concentration at which a subject could detect a taste was established for each subject.

The median threshold concentration to detect taste in the native ground fenugreek seed mixture was 0.0001 mg/ml. In comparison, the median threshold concentration to detect taste in

the RHUBICINE™ was significantly higher, 0.005mg/ml ($p<0.0001$). Therefore, the median threshold concentration at which taste could be detected in RHUBICINE™ was approximately 50-fold higher than the analogous threshold concentration in native fenugreek. The results are presented in Table 3.

Table 3.

Taste Threshold: Comparison of RHUBICINE™ and Native Fenugreek		
Concentration of fenugreek sample (mg/ml)	# of subjects with threshold taste at this concentration (N=50)	# of subjects with threshold taste at this concentration (N=50)
	RHUBICINE™	native fenugreek
0.00001	0	0
0.00005	0	7
0.0001	3	32
0.0005	5	6
0.001	6	3
0.005	28	2
0.01	5	0
0.05	3	7
0.1	0	0
0.5	0	0

Example 5: Measurement of the Average Organoleptic Odor Detection Thresholds for RHUBICINE™ and Native Fenugreek.

The same fenugreek samples used in Example 4 were used to determine threshold odor concentration. Prior to each testing, the tubes were shaken for a few seconds by hand and a cotton swab was dipped into the various solutions. The same subject to be tested was then given the swab to smell to determine if any odor was detected. The fifty subjects used in the test were healthy individuals between the ages of 21 and 60. The solutions were tested in increasing concentration of fenugreek beginning with a control tube containing deionized water only. The order of testing between RHUBICINE™ and native fenugreek was randomized between subjects. All testing was conducted by a single tester. A threshold concentration at which a subject could

detect an odor was established for each subject.

The median threshold concentration to detect odor in the native ground fenugreek seed mixture was 0.0005 mg/ml. In comparison, the median threshold concentration to detect taste in the RHUBICINE™ was significantly higher, 0.05mg/ml ($p<0.0001$). Therefore, the median threshold concentration at which odor could be detected in RHUBICINE™ was approximately 100-fold higher than the analogous threshold concentration in native fenugreek. The results are presented in Table 4.

Table 4

Odor Threshold: Comparison of RHUBICINE™ and Native Fenugreek		
Concentration of fenugreek sample (mg/ml)	# of subjects with threshold odor at this concentration (N=50)	# of subjects with threshold odor at this concentration (N=50)
	RHUBICINE™	Native fenugreek
0.00001	0	0
0.00005	0	0
0.0001	0	5
0.0005	0	26
0.001	●	8
0.005	4	6
0.01	5	5
0.05	31	0
0.1	5	0
0.5	4	0

Example 6: Comparison of the Viscosity of RHUBICINE™ and Native Fenugreek in an Aqueous Solution.

Viscosity Test: 5 grams of RHUBICINE™ or native fenugreek was added to a 50 ml glass beaker to which 50 ml of deionized water was added. The mixture was stirred well and allowed to stand for 1 hour at room temperature, with mixing after 30 and 60 minutes. After 60 minutes, 60 ml of ENSURE COMPLETE BALANCED NUTRITION™, Vanilla flavor (Ross Products Division, Abbott Laboratories, Columbus, OH) was added to the mixture, which was then mixed

well and passed through a metal screen strained to break up any large clumps of fenugreek. A Boekel #5 Zahn cup viscometer was filled completely with 44 ml of the test solution and using a stop watch, the time it takes for the cup to drain completely was measured. The experiment was run three times for each sample, and the average number of seconds calculated for the cup to empty completely. The data is reported in Zahn seconds. A control solution was run using ENSURE COMPLETE BALANCED NUTRITION™ liquid to which no fenugreek had been added.

The results are presented in Table 5. Increasing the concentrations of both RHUBICINE™ and native fenugreek caused increased and comparable viscosity.

Table 5

Viscosity of RHUBICINE™ and Native Fenugreek		
Concentration of fenugreek preparation (mg/ml)	Viscosity of RHUBICINE™ Mixture (seconds)	Viscosity of Native Fenugreek (seconds)
0	14	14
50	21	23
100	35	33
200	57	61
300	136	128

Example 7: Comparison of the Friction Properties of RHUBICINE™ and Native Fenugreek.

Friction Testing: Friction testing was performed with standardized apparatus that measures static friction. The same fenugreek-Ensure solutions used in the viscosity protocol were used in the friction testing. A 100 mm x 200 mm area was marked on a melamine-surfaced board. Before each test the board was cleaned thoroughly. A small aliquot of the mixture to be tested was poured into a weight boat and a 200 gram Ohaus weight with a round flat contact surface 31 mm in diameter was dipped into the mixture. The weight was then placed on a spot 333 mm away from the axis of rotation, and the end of the board raised slowly until the weight begins to slide. A ruler attached to a pole near the apparatus was used to read the height in mm of the board that was required to begin the weight sliding. Because the height measured in mm is proportional to the angle of repose, this measurement is proportional to the coefficient of static friction.

Example 8: Comparison of the Glucose Binding Properties of RHUBICINE™ *and Native Fenugreek by Analyzing Impairment of Glucose Transport through Dialysis Tubing.*

Impairment of Glucose Transport through Dialysis Tubing: Various quantities of RHUBICINE™ or native fenugreek were added to 10 ml of water containing 5% glucose. After sitting for 1 hour at room temperature, the various fenugreek mixtures were placed in a standard dialysis tubing and dialyzed for 90 minutes at room temperature against deionized water. At the end of this time, the dialysate was assayed for the concentration of glucose. In other experiments, various quantities of RHUBICINE™ or native fenugreek were added to 10 ml of a 1:1 mixture of ENSURE COMPLETE BALANCED NUTRITION™ liquid and water containing 10% glucose. After sitting for 1 hour at room temperature, the various fenugreek-Ensure mixtures were placed in a standard dialysis tubing and dialyzed for 90 minutes at room temperature against deionized water. At the end of this time, the dialysate was assayed for the concentration of glucose using a glucometer.

The results are shown in Table 6. Increasing concentrations of both RHUBICINE™ and native fenugreek caused increasing and comparable impairment of glucose transport across the dialysis tubing.

Table 6

Effect of Various RHUBICINE™ and Native Fenugreek Mixtures on Passage of Glucose Through Dialysis Tubing		
Concentration of fenugreek preparation (mg/ml)	% of maximum glucose of RHUBICINE™ mixtures	% of maximum glucose of Native Fenugreek
0	100	100
50	87	83
100	68	70
200	42	39
300	22	24

Example 9: The RHUBICINE™ Exhibits Hypoglycemic Activity.

10 normal subjects were fed a standardized 500 kcal metabolic meal. Experimental subjects were administered a 120ml serving of RHUBICINE™ in the form of a gel (hereinafter referred to as LIMITROL-DM™ a flavored gel-like formulation containing 10 grams of RHUBICINE™/dose) immediately before the meal. Control subjects were not given any

fenugreek.

A maximum rise in blood glucose observed in the control subjects after the meal was 55 mg/%. A maximum rise in blood glucose observed in the experimental subjects after the meal was only 31 mg/%

Example 10: A Cholesterol Containing Comestible Product Exhibits Reduced Cholesterol Levels after Treatment with RHUBICINE™.

Cholesterol-Binding: 25 grams of dried whole egg solids (Oskaloosa Food Products Corp., Oskaloosa, Iowa) was added to 150 ml of water and mixed for one hour at room temperature. 45 ml of the egg solid solution, containing 6.25 grams of dried whole egg solid was placed in a 50 ml plastic centrifuge tube and various quantities of RHUBICINE™ or native fenugreek was added. The tubes were rocked continuously for 30 minutes at room temperature and centrifuged x 1500 g for 5 minutes. The supernatant was collected, mixed 1:1 with ethanol, and centrifuged x 1500 g for 5 minutes. The supernatant was collected and assayed for cholesterol concentration using a Kobas automated chemical analyzer.

The solution that was mixed with the RHUBICINE™ absorbed comparable levels of cholesterol to the control solution that was mixed with the native fenugreek. The % cholesterol absorbed in both instances increased with increasing concentrations of fenugreek. These data are set forth in Table 7.

Table 7

% Cholesterol Absorption by RHUBICINE™ and Native Fenugreek		
Amount of fenugreek	% cholesterol absorbed by RHUBICINE™	% cholesterol absorbed by native fenugreek
0	0	0
.25 g	36	32
.50 g	47.2	51.3
.75	73.8	82.9
1.0 grams	94.0	92.3
2.0 grams	99.1	98.7

Example 11: The RHUBICINE™ Exhibits Hypocholesteremic Activity.

Methods

20 subjects, 13 men and 7 women, between the ages of 39 and 63, participated in the study. Each subject was healthy, except for the presence of mild-moderate hypercholesteremia and none had diabetes, prior history of cardiovascular disease, irritable bowel syndrome or other disturbance of gastrointestinal motility. During the course of this study, patients were allowed a free-living diet, but requested to make no changes in their usual eating habits with regard to the quantity or nature of food consumed.

Each subject took two servings of LIMITROL-DM™ each day, immediately prior to eating their two largest meals of the day.

All subjects fasted from the previous midnight on the morning that blood was drawn. Blood was obtained from each subject by routine venipuncture within 1 month prior to starting the LIMITROL-DM™, and again on the first morning (Day 1) of starting LIMITROL-DM™ supplementation. Baseline levels were the average of these two pre-treatment tests. Additional blood test were also obtained after 2, 4 and 6 weeks of taking LIMITROL-DM™. Serum total cholesterol was determined by a Cobas chemistry detector.

The study was approved by an Institutional Review Board and informed consent obtained from all subjects prior to study entry.

Results

The average baseline serum total cholesterol of the 20 subjects was 271, with a range of 232-320. The serum total cholesterol was lowered an average of 7.01% after the initial 2 weeks of LIMITROL-DM™ administration, 16.61% after 4 weeks, and 20.30% after 6 weeks. These values were all highly significant. The subjects self-reported that they received 1532 dosages out of a possible total of 1680 (91.2% compliance). The range of self-reported subject compliance was 76.8-100.0%. There was no statistically significant correlation between compliance and reduction of serum total cholesterol. No subject needed to be terminated from the study because of adverse effects although 2/20 patients self-reported mild increases in flatulence that was acceptable. An additional 6/20 subjects self-reported improved bowel regularity. A paired t-test was used to compare the serum total cholesterol levels for each individual at various time points.

Example 12: Comparison of the effects of grind size on cholesterol binding and post-prandial glucose levels.

RHUBICINE™ was ground to various sizes using a spiral air jet mill (PowderSize, Quaker Town PA). Table 8 sets forth the particle size distribution and the relative degree of coarseness of the fenugreek seed material produced.

Table 8

Relative Degree of Coarseness of Product	Thru 80 Mesh	Thru 100 Mesh	Thru 140 Mesh	Thru 200 Mesh
Fine	85%	80%	65%	50%
Coarse	17%	10%	8%	2%

The material was then subjected to several *in vitro* tests to analyze the effect of grind size on cholesterol binding and the ability to alter the physical properties of a solution with which it is mixed.

1. Cholesterol binding: A cholesterol binding assay was performed as described above in Example 10 except that various grind sizes of the RHUBICINE™ were used. The results are shown in Figure 1. The control solution did not contain any fenugreek seed material. As shown in Figure 1, the intermediate-coarse size material bound cholesterol most effectively, with 70.79% of the cholesterol being bound.

2. Viscosity and Friction (slipperiness) Analysis: The friction and viscosity properties of RHUBICINE™ material mixed with water was determined as described above in Examples 6 and 7 except that various grind sizes of the RHUBICINE™ material were used. The results are shown in Figures 2 and 3 respectively. The control solution was water. As shown in Figures 2 and 3, the intermediate-coarse size material was the most slippery (lowest friction) and the most viscous.

Example 13: Preparation of a Fenugreek Gel.

10.0 grams of RHUBICINE™ was mixed with 115 ml of water and lime flavor extract. The material was heated to 180°C briefly and then packed into a plastic cup and sealed to produce LIMITROL-DM™.

Example 14: Preparation of a Fenugreek Liquid.

5.0 grams of RHUBICINE™ was mixed with 360 ml of water and chocolate flavor. The material was shaken for two minutes and packaged into a container to produce a liquid drink mix referred to as LIMITROL-CL™.

Example 15: Preparation of a Fenugreek Seed Material Containing Comestible.

5.0 grams of RHUBICINE™ was mixed with 120 ml of ice cream that had been defrosted. The material was then refrozen for consumption.

Each of the foregoing patents, patent applications and references is herein incorporated by reference in its entirety. Having described the presently preferred embodiments in accordance with the present invention, it is believed that other modifications, variations and changes will be suggested to those skilled in the art in view of the teachings set forth herein. It is, therefore, to be understood that all such variations, modifications, and changes are believed to fall within the scope of the present invention as defined by the appended claims.

What we claim is:

Claims

1. An article of manufacture comprising:

a flaked or ground, alcohol-extracted fenugreek seed material containing at least 80% of the carbohydrate components present in fenugreek seeds and less than 20% of the fat components present in fenugreek seeds and wherein the fenugreek seed material has substantially reduced taste and odor versus flaked or ground fenugreek seeds.

2. The fenugreek seed material of claim 1, wherein the fenugreek seed material is methanol extracted and wherein the fenugreek seed material has less than 100 parts per million of methanol.

3. The fenugreek seed material of claims 1 or 2 wherein the fenugreek seed material has the following components in the following proportions:

protein	20-40%
carbohydrate	40-70%
ash	2-5%
fat	<1%
moisture	1-10%.

4. The fenugreek seed material of claim 2, wherein the fenugreek seed material is methanol extracted by a counter current extraction procedure at a temperature of less than 60°C.

5. The fenugreek seed material of claim 1, wherein an ethanol supernatant of the fenugreek seed material has a spectrometric value of at least 20% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek seeds.

6. The fenugreek seed material of claim 1, wherein an ethanol supernatant of the fenugreek seed material has a spectrometric value of at least 60-70% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek seeds.

7. The fenugreek seed material of claim 1, wherein an ethanol supernatant of the fenugreek

seed material has a spectrometric value of at least 80% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek seeds.

8. The fenugreek seed material of claim 1, wherein an ethanol supernatant of the fenugreek seed material has a spectrometric value of at least 90% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek seeds.

9. A fenugreek seed material comprising:

at least 50% of the protein components present in fenugreek seeds, at least 80% of the carbohydrate components present in fenugreek seeds, at least 50% of the ash components present in fenugreek seeds, and less than 20% of the fat components present in fenugreek seeds and wherein the fenugreek seed material has substantially reduced taste and odor versus flaked or ground fenugreek seeds.

10. A gel composition, comprising the fenugreek seed material of claims 1 or 9 formulated as a fenugreek gel having a fenugreek seed material concentration of between 0.05 and 0.2 grams/milliliter of aqueous solution.

11. The gel composition of claim 10, wherein the fenugreek gel has a pH of between 3.5 and 7.

12. The gel composition of claim 10, wherein the fenugreek gel has a salt concentration of less than 0.01%.

13. A liquid composition, comprising the fenugreek seed material of claims 1 or 9 formulated as a fenugreek liquid having a fenugreek seed material concentration of more than 0.002 and less than 0.05 grams/milliliter of aqueous solution.

14. The liquid composition of claim 13, wherein the fenugreek liquid has a pH of between 3.5 and 7.

15. The liquid composition of claim 13, wherein the fenugreek liquid has a salt concentration

of less than 0.01%.

16. The fenugreek seed material of claims 9, 10, or 13, wherein an ethanol supernatant of the fenugreek seed material has a spectrometric value of at least 20% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek seeds.

17. The fenugreek seed material of claims 9, 10, or 13, wherein an ethanol supernatant of the fenugreek seed material has a spectrometric value of at least 60-70% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek seeds.

18. The fenugreek seed material of claims 9, 10, or 13, wherein an ethanol supernatant of the fenugreek seed material has a spectrometric value of at least 80% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek seeds.

19. The fenugreek seed material of claims 9, 10, or 13, wherein an ethanol supernatant of the fenugreek seed material has a spectrometric value of at least 90% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek seeds.

20. A composition comprising:

a fenugreek seed material formulated as a fenugreek powder having substantially reduced taste and odor versus flaked or ground fenugreek seeds, wherein the fenugreek powder includes at least 80% of active components found in an unmodified fenugreek, and wherein the active components are protein, saponins, and carbohydrate.

21. The composition of claim 20, further comprising at least one capsule containing the fenugreek powder for storage and administration of the fenugreek powder.

22. The composition of claim 21, wherein the fenugreek powder is in the at least one capsule in an amount effective for reducing the intestinal absorption of a caloric compound selected from the group consisting of a lipid, a protein, a carbohydrate and a cholesterol.

23. The composition of claim 20, further comprising a comestible, wherein the fenugreek

powder is mixed with the comestible.

24. The composition of claim 20, wherein the fenugreek powder has 10% or less of the odor and/or taste of native fenugreek based on the average organoleptic taste and/or odor detection thresholds.

25. A gel composition, comprising the fenugreek powder of claim 20 formulated as a fenugreek gel having a fenugreek seed material concentration of between 0.05 and 0.2 grams/milliliter of aqueous solution.

26. The gel composition of claim 25, wherein the fenugreek gel has a pH of between 3.5 and 7.

27. The gel composition of claim 25, wherein the fenugreek gel has a salt concentration of less than 0.01%.

28. The gel composition of claim 25, further comprising a carrageenan based gelatin wherein the fenugreek gel is immersed in the carrageenan based gelatin.

29. The gel composition of claim 28, wherein the fenugreek gel is present in clumps within the carrageenan based gelatin.

30. The gel composition of claim 25, further comprising a comestible, wherein the fenugreek gel is mixed with the comestible to produce a fenugreek-comestible product.

31. The gel composition of claim 25, wherein the fenugreek gel contains between 5 and 15 g of the fenugreek powder.

32. A liquid composition, comprising the fenugreek powder of claim 20 formulated as a fenugreek liquid having a fenugreek seed material concentration of more than 0.002 and less than 0.05 grams/milliliter of aqueous solution.

33. The liquid composition of claim 32, wherein the fenugreek liquid has a pH of between 3.5 and 7.

34. The liquid composition of claim 32, wherein the fenugreek liquid has a salt concentration of less than 0.01%.

35. The liquid composition of claim 32, further comprising a comestible, wherein the fenugreek liquid is mixed with the comestible.

36. The liquid composition of claim 32, wherein the fenugreek liquid contains between 5 and 15 grams of the fenugreek powder.

37. The composition of claims 20, 21, 25, or 32, wherein an ethanol supernatant of the fenugreek seed material has a spectrometric value of at least 20% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek seeds.

38. The composition of claims 20, 21, 25, or 32, wherein an ethanol supernatant of the fenugreek seed material has a spectrometric value of at least 60-70% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek seeds.

39. The composition of claims 20, 21, 25, or 32, wherein an ethanol supernatant of the fenugreek seed material has a spectrometric value of at least 80% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek seeds.

40. The composition of claims 20, 21, 25, or 32, wherein an ethanol supernatant of the fenugreek seed material has a spectrometric value of at least 90% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek seeds.

41. A method for reducing the intestinal absorption of a caloric compound from a comestible product in a human, comprising the step of:

orally delivering a fenugreek seed material having at least 50% of the protein components present in fenugreek seeds, at least 80% of the carbohydrate components present in fenugreek

seeds, at least 50% of the ash components present in fenugreek seeds, and less than 20% of the fat components present in fenugreek seeds and wherein the fenugreek seed material has substantially reduced taste and odor versus flaked or ground fenugreek seeds, and a comestible product to the human.

42. The method of claim 41, wherein the fenugreek seed material is formulated as a gel having a fenugreek seed material concentration of between 0.05 and 0.2 grams/milliliter and containing between 5 and 15 grams of the fenugreek seed material.

43. The method of claim 42, wherein the gel is delivered less than 30 minutes before the comestible product.

44. The method of claim 41, wherein the fenugreek seed material is formulated as a liquid having a fenugreek seed material concentration of more than 0.002 and less than 0.05 grams/milliliter and containing between 5 and 15 grams of the fenugreek seed material.

45. The method of claim 41, wherein the liquid is delivered less than 30 minutes before the comestible product.

46. The method of claim 41, wherein the caloric compound is selected from the group consisting of a lipid, a protein, and a carbohydrate.

47. A method for reducing the intestinal absorption of cholesterol from a cholesterol containing comestible product in a human, comprising the step of:

orally delivering a fenugreek seed material having at least 50% of the protein components present in fenugreek seeds, at least 80% of the carbohydrate components present in fenugreek seeds, at least 50% of the ash components present in fenugreek seeds, and less than 20% of the fat components present in fenugreek seeds and wherein the fenugreek seed material has substantially reduced taste and odor versus flaked or ground fenugreek seeds, and a cholesterol containing comestible product to the human.

48. The method of claim 47, wherein the fenugreek seed material is formulated as a

fenugreek gel having a fenugreek seed material concentration of between 0.05 and 0.2 grams/milliliter and contains between 5 and 15 grams of the fenugreek seed material.

49. The method of claim 48, wherein the gel is delivered less than 30 minutes before the cholesterol containing comestible product.

50. A method for reducing cholesterol in a comestible product, comprising the steps of:

mixing a fenugreek seed material having at least 50% of the protein components present in fenugreek seeds, at least 80% of the carbohydrate components present in fenugreek seeds, at least 50% of the ash components present in fenugreek seeds, and less than 20% of the fat components present in fenugreek seeds and wherein the fenugreek seed material has substantially reduced taste and odor versus flaked or ground fenugreek seeds, with a cholesterol containing comestible product to produce a fenugreek comestible mixture,

mixing the fenugreek comestible mixture to separate the fenugreek comestible mixture into a fenugreek-cholesterol containing solution and a cholesterol free comestible solution; and,

isolating the cholesterol free comestible solution.

51. An alcohol extracted fenugreek seed material produced by the steps of:

flaking a fenugreek seed to form a fenugreek preparation

extracting soluble components from the fenugreek preparation by extraction of the fenugreek preparation with an alcohol solvent at a cool extraction temperature to produce a fenugreek solid;

treating the fenugreek solid to remove the alcohol solvent to produce a dry solid; and,

grinding the dry solid into a powder to produce a fenugreek seed material.

52. The fenugreek seed material of claim 51, wherein the fenugreek preparation is extracted by a counter current extraction procedure.

53. The fenugreek seed material of claim 52, wherein the counter current extraction is performed in an extractor which is selected from the group consisting of a Crown Extractor, a French Extractor a continuous Loop Extractor, and a Shallow Bed Extractor.

54. The fenugreek seed material of claim 51, wherein the alcohol solvent used to extract the soluble components from the fenugreek preparation is methanol.

55. The fenugreek seed material of claim 51, wherein the alcohol solvent used to extract the soluble components from the fenugreek preparation is about 10% ethanol and 90% methanol.

56. The fenugreek seed material of claim 51, further comprising the step of mixing the fenugreek seed material with an aqueous solution to produce a fenugreek gel.

57. The fenugreek seed material of claim 56, wherein the aqueous solution in which the fenugreek seed material is mixed has a pH of between 3.5 and 7.

58. The fenugreek seed material of claim 56, wherein the aqueous solution in which the fenugreek seed material is mixed has a salt concentration of less than 0.01%.

59. The fenugreek seed material of claim 56, wherein an ethanol supernatant of the fenugreek seed material has a spectrometric value of at least 20% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek seeds.

60. The fenugreek seed material of claim 56, wherein an ethanol supernatant of the fenugreek seed material has a spectrometric value of at least 60-70% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek seeds.

61. The fenugreek seed material of claim 56, wherein an ethanol supernatant of the fenugreek seed material has a spectrometric value of at least 80% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek seeds.

62. The fenugreek seed material of claim 56, wherein an ethanol supernatant of the fenugreek seed material has a spectrometric value of at least 90% less than a spectrometric value of an ethanol supernatant of the flaked or ground fenugreek seeds.

63. A fenugreek seed material comprising:

a flaked or ground fenugreek seed material having an OD390 value of more than 20% less than native fenugreek when dissolved in ethanol and measured in a spectrometer.

64. A gel composition, comprising the fenugreek seed material of claim 63 formulated as a fenugreek gel having a fenugreek seed material concentration of between 0.05 and 0.2 grams/milliliter of aqueous solution.

65. The gel composition of claim 64, wherein the fenugreek gel has a pH of between 3.5 and 7.

66. The gel composition of claim 64, wherein the fenugreek gel has a salt concentration of less than 0.01%.

67. A liquid composition, comprising the fenugreek seed material of claim 63 formulated as a fenugreek liquid having a fenugreek seed material concentration of more than 0.002 and less than 0.05 grams/milliliter of aqueous solution.

68. The liquid composition of claim 67, wherein the fenugreek liquid has a pH of between 3.5 and 7.

69. The liquid composition of claim 67, wherein the fenugreek liquid has a salt concentration of less than 0.01%.

70. A fenugreek seed material comprising:

a flaked or ground fenugreek seed material having an OD390 value of at least 60-70% less than native fenugreek when dissolved in ethanol and measured in a spectrometer.

71. A fenugreek seed material comprising:

a flaked or ground fenugreek seed material having an OD390 value of at least 80% less

than native fenugreek when dissolved in ethanol and measured in a spectrometer.

72. A fenugreek seed material comprising:

a flaked or ground fenugreek seed material having an OD390 value of at least 90% less than native fenugreek when dissolved in ethanol and measured in a spectrometer.

73. A composition for treating a diabetic, comprising

a fenugreek seed material as claimed in claims 1, 9 or 20 and a hypoglycemic agent.

74. The composition of claim 73, wherein the hypoglycemic agent is selected f rom the group consisting of insulin, sulfonylureas, metaformin and acarbose.

75. A composition, comprising:

a fenugreek seed material as claimed in claims 1, 9 or 20 and a hypocholesteremic agent.

76. The composition of claim 75, wherein the hypocholesteremic agent is an HMG-coenzyme reductase inhibitor.

77. A method of preparing an alcohol extracted fenugreek seed material, comprising the steps of:

flaking a fenugreek seed to form a fenugreek preparation

extracting soluble components from the fenugreek preparation by extraction of the fenugreek preparation with an alcohol solvent at a cool extraction temperature to produce a fenugreek solid;

treating the fenugreek solid to remove the alcohol solvent to produce a dry solid; and,

grinding the dry solid into a powder to produce the fenugreek seed material.

78. The method of claim 77, wherein the cool extraction temperature is between 30°C and 60°C.

79. The method of claim 77, wherein the cool extraction temperature is less than 55°C.

80. The method of claim 77, wherein the extraction step is a counter current extraction.

81. The method of claim 80, wherein the counter current extraction is performed in an extractor which is selected from the group consisting of a Crown Continuous Loop Shallow Bed Extractor and a French Extractor.

82. The method of claims 77, 78, 79, 80 or 81, wherein the alcohol solvent is methanol.

83. The method of claim 77, wherein the alcohol solvent is about 10% ethanol and 90% methanol.

84. The method of claim 82, wherein the fenugreek solid is treated by the steps of desolventization, solvent wash, and drying.

85. The method of claim 84, wherein the desolventization process is performed in a desolventizer toaster.

86. The method of claim 84, wherein the solvent wash is a series of ethanol washes and wherein the methanol is removed by the ethanol washes such that the dry solid has less than 100 parts per million of methanol.

87. The method of claim 84, wherein the drying process is performed in a tumble dryer.

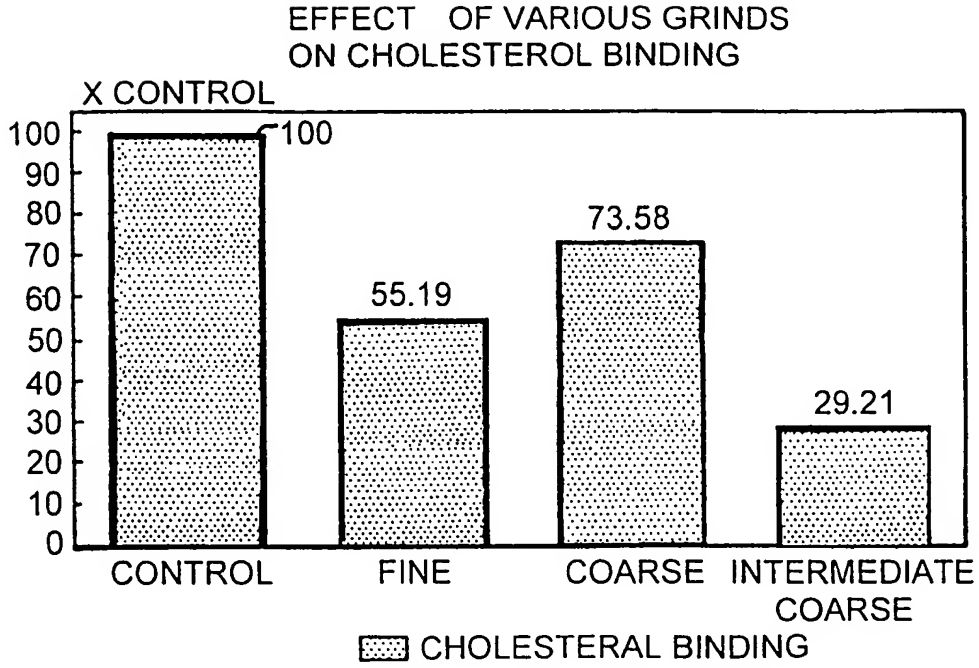
EFFECT OF VARIOUS GRINDS
ON CHOLESTEROL BINDING
X CONTROL
100
90
80
70
60
50
40
30
20
10
0
100
55.19
73.58
29.21
CONTROL
FINE
COARSE
INTERMEDIATE COARSE
CHOLESTERAL BINDING

Fig. 1

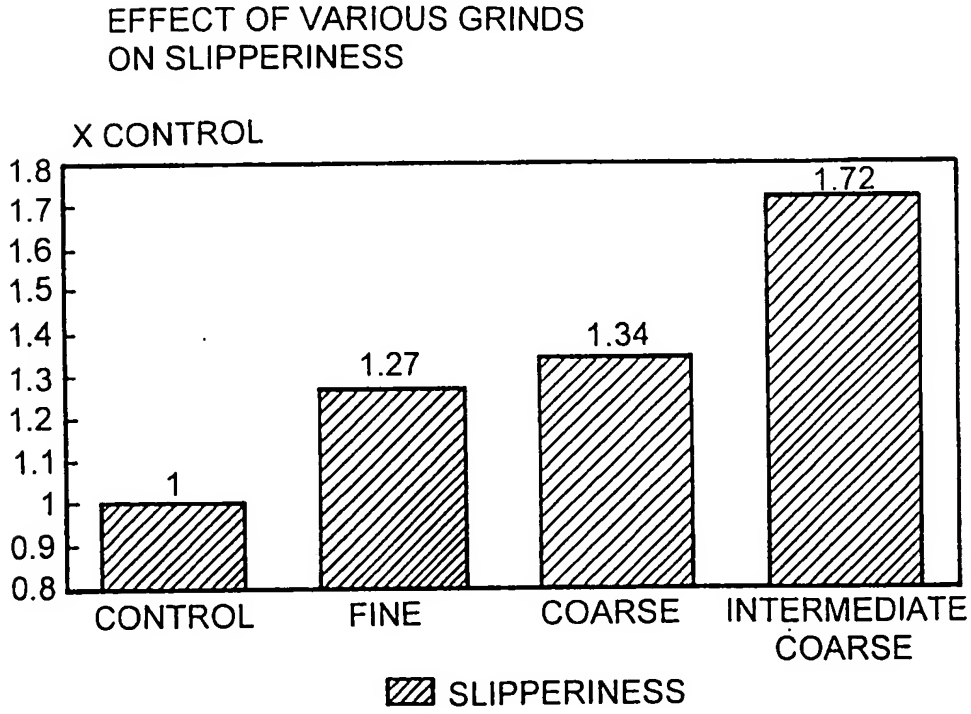
EFFECT OF VARIOUS GRINDS
ON SLIPPERINESS
X CONTROL
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
1
1.27
1.34
1.72
CONTROL
FINE
COARSE
INTERMEDIATE COARSE
SLIPPERINESS

Fig. 2

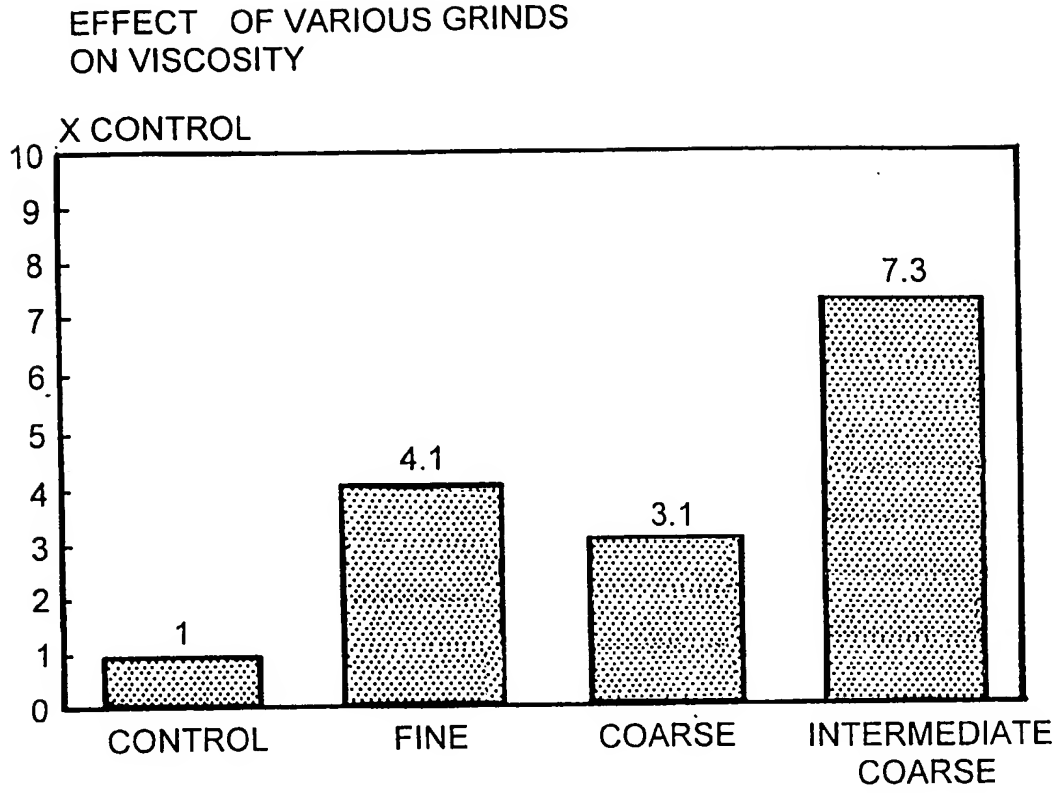
EFFECT OF VARIOUS GRINDS
ON VISCOSITY
X CONTROL
10
9
8
7
6
5
4
3
2
1
0
1
4.1
3.1
7.3
CONTROL
FINE
COARSE
INTERMEDIATE
COARSE

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/24482

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A01N 65/00; A23F 3/34; A23L 1/10, 1/28, 1/36

US CL :424/195.1; 426/425, 427, 428, 429, 430, 629

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 424/195.1; 426/425, 427, 428, 429, 430, 629

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

08/972,279 and 08/972,825

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS, JPOAPS, EPOAPS, BIOSIS, BIOTECHDS, CABA, FSTA, LIFESCI
search terms: Fenugreek, alcohol extract, extract, flaked, etc.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,658,571 A (GOPALAN et al) 19 August 1997, col. 3-4, all lines and the abstract.	1-15, 41, 46 and 77-87
A	US 5,449,823 A (LERCH) 12 September 1995, see the abstract.	1-15, 41, 46 and 77-87
A	US 5,464,613 A (BARCAY et al) 07 November 1995, see the abstract.	1-15, 41, 46, and 77-87
X	WO 95/21199 A1 (YISSUM RESEARCH DEVELOPMENT COMPANY OF THE HEBREW UNIVERSITY OF JERUSALEM) 10 August 1995 (10.08.95), see pages 9-10, all lines.	1-2 and 4-8

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

05 FEBRUARY 1999

Date of mailing of the international search report

25 FEB 1999

Name and mailing address of the ISA/US
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/24482

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X - Y	SHARMA, R.D. Effect of Fenugreek Seeds and Leaves On Blood Glucose and Serum Insulin Responses in Human Subjects. Nutrition Research. 1986, Vol. 6, pages 1353-1364, especially page 1355.	1-9 ----- 1-9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/24452 03 MAR 1999

WIPO PCT

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 16-19
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
1-15

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING
This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I, claims 1-9, 41,46 and 77-87 drawn to a fenugreek seed material and compositions thereof, method of using it to reduce intestinal absorption of caloric compounds, and method of making the seed material.

Group II, claim(s) 10-12 drawn to a fenugreek compositions in gel form.

Group III, claim(s) 13-15, drawn to liquid fenugreek compositions.

Group IV, claim(s) 20-24 and 37-40, drawn to fenugreek compositions comprising at least 80% of the active components found in unmodified fenugreek compositions and compositions thereof.

Group V, claim(s) 25-31 and 37-40, drawn to fenugreek compositions comprising at least 80% of the active components found in unmodified fenugreek compositions in gel form.

Group VI, claim(s) 32-40, drawn to fenugreek compositions comprising at least 80% of the active components found in unmodified fenugreek compositions in liquid form.

Group VII, claim(s) 42-43, drawn to a method of reducing the intestinal absorption of caloric compounds using gel form compositions.

Group VIII, claim(s) 44-45, drawn to a method of reducing the intestinal absorption of caloric compounds using liquid form compositions.

Group IX, claim(s) 47-49, drawn to second method of reducing intestinal absorption of cholesterol.

Group X, claim(s) 50-62, drawn to alcohol extracted fenugreek material.

Group XI, claim(s) 63-66 drawn to fenugreek material in flaked or ground form having a gel composition and further having an OD390 more than 20% less than native fenugreek dissolved in ethanol and measured in a spectrometer.

Group XII, claim(s) 67-69 drawn to fenugreek material in flaked or ground form having a liquid composition and further having an OD390 more than 20% less than native fenugreek dissolved in ethanol and measured in a spectrometer.

Group XIII, claim(s) 70-72 drawn to fenugreek material in flaked or ground form having an OD390 of at least 60-70% less than native fenugreek dissolved in ethanol and measured in a spectrometer.

Group XIV claim(s) 73-74, drawn to compositions for treating diabetics.

Group XV, claim(s) 75-76, drawn to fenugreek compositions comprising hypocholesterolemic agents.

The inventions listed as Groups I-XII do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the various fenugreek preparations are different since they are materials of different forms possessing different characteristics.